This paper reports the result of the chemical analysis of the Chinese coin Yongle Tongbao owned by Khabarovsk Regional Museum named after N.I. Grodekov. It was found that this Yongle Tongbao is the officially minted coin. This coin was excavated in Krasnokurovka burial ground in the Khabarovsk Territory. The burial ground was made under the Pokrovka culture (from the 9th to the 13th centuries). However the Yongle Tongbao, which was first minted in 1408, was discovered in the mound No. 30 of Krasnokurovka burial ground. So, it is necessary to reconsider the end period of the Pokrovka culture.

**Key words:** Excavated coin, Yongle Tongbao, Khabarovsk Territory, Chemical analysis, Pokrovka culture

1. Preface

The authors, Nakamura Miyake and Murakushi visited the Khabarovsk Regional Museum named after N.I. Grodekov (In this paper, it is abbreviated as Khabarovsk Museum) from Dec. 23rd to Dec. 28th in 2016, and investigated the glass beads and excavated coins. The 11 members from Japan were Prof. OGUCHI Masashi (Hosei University), Prof. KOJIMA Yoshitaka (Kanazawa Gakuin University), Prof. NAKAI Izumi, Mr. BABA Shunsuke, Ms. IMAI Aiko (Tokyo University of Science), Dr. Sergey V. LAPTEV (MIHO MUSEUM), Dr. NAKASAWA Hiromasa (Aomori Prefecture Education Board), Ms. TAKAHASHI Misuzu (Samani Town Board of Education) and the authors. On the Russian side, Mr. Artur R. LASKIN of Department of Cultural Heritage under the Government of the Khabarovsk Territory and one of the authors, Gorshkov accepted the team from Japan.

Miyake and Nakamura investigated the Chinese, Japanese, and Korean coins on Dec. 26th and 27th with the help of Gorshkov. Other members made investigation and chemical analysis of glass beads. Murakushi made chemical analysis of excavated coin the Yongle Tongbao (永樂通寶: first minted in 1408) in Dec. 26th. In the present paper we report about the chemical analysis of Yongle Tongbao which was discovered from Krasnokurovka burial ground in Khabarovsk Territory.

2. The Yongle Tongbao excavated in Japan including Hokkaido Island

In the middle ages of Japan, people usually used
Chinese coins of Tang (唐), Northern Song (北宋), Southern Song (南宋) and Ming (明) era. Japanese coins were very rare. The Yongle Tongbao was first minted in 1408, early Ming era. This coin was excavated in large quantities in Japan including Hokkaido Island. But it has almost never been discovered in China, Mongolia and Northeast Asia\(^1\). There are only two cases of discovery in Northeast Asia. One is from Vangrkvo on Chaivo Bay in northern Sakhalin Island\(^2\) and another is from Krasnokurovka burial ground in Khabarovsk Territory. One of the authors, Miyake, pointed out that the Yongle Tongbao discovered in northern Sakhalin Island could have been brought from Japan\(^3,4\).

And then we present the Yongle Tongbao excavated in Hokkaido Island. To this date, five hoards of coins have been discovered in Hokkaido Island (Fig.1). The first hoard of coins was excavated in Shinori (志海苔), Hakodate City. Accordingly, these coins are referred to as the Shinori Kosen in Japanese ("Shinori ancient coins" - hereunder "Shinori hoard"). The Shinori hoard contains 387,515 coins comprising 97 varieties, from the Sizhu Banliang (四銖半両: first minted in 175 BC) to the Hongwu Tongbao (洪武通寶: first minted in 1368). The second hoard of coins was discovered in the remains of Suzakidate (洲崎館), Kaminokuni Town, which is called the Suzakidate Kosen in Japanese (hereunder "Suzakidate hoard"). The Suzakidate hoard contains 490 coins comprising 35 varieties, from the Kaiyuan Tongbao (開元通寶: first minted in 621) to the Yongle Tongbao. Suzakidate hoard was discovered in 1954, but it has been almost lost now\(^5\). The third hoard of coins was discovered in Wakimoto (涌元), Shiriuchi Town, which is called the Wakimoto Kosen in Japanese (hereunder, "Wakimoto hoard"). The Wakimoto hoard contains 996 coins comprising 39 varieties, from the Kaiyuan Tongbao to the Xuande Tongbao (宣徳通寶: first minted in 1433).

The fourth hoard was discovered in Kabari (賀張), Hidaka Town, which is called the Kabari Kosen in Japanese (hereunder, "Kabari hoard"). The Kabari hoard contains 664 coins comprising 35 varieties, from the Kaiyuan Tongbao to the Xuande Tongbao. The fifth and final hoard was discovered in Kotanhana (コタン浜), Rumoi City, which is called the Kotanhana Kosen in Japanese (hereunder, Kotanhana hoard\(^6\)). The Kotanhana hoard contains 460 coins comprising 43 varieties, from the Kaiyuan Tongbao to the Xianfeng Tongbao (咸豊通寶: first minted in 1851). Hakodate city, Shiriuchi and Kaminokuni towns are all located in the Oshima Peninsula, which is in the southwestern part of

![The territory of Japanese people in the middle of 15th century.](image)

Fig. 1 Five hoards of coins in Hokkaido Island
Hokkaido. Hidaka town is situated in the southern part of Hokkaido, and Rumoi city is situated in the northern part of it. Hidaka town and Rumoi city were the out of the territory of Japanese people in the middle of 15th Century. So it is certain that the Kabari hoard was owned by Ainu. The Kotanhama hoard needs careful examination, because this hoard includes coins of 19th Century.

We show the Yongle Tongbao in five hoards. Shinori hoard has no coin, Suzakidate hoard has 53 coins. Wakimoto hoard has 205 coins, Kabari hoard has 216 coins and Kotanhama hoard has 7 coins.

One of the authors, Nakamura, and his students made investigations and chemical analysis of the Yongle Tongbao in Wakimoto, Kabari and Kotanhama hoard. The purpose of the study was to clarify the ratio of officially minted and privately minted coins of the Yongle Tongbao in Hokkaido Island.

In the middle ages of China and Japan, Chinese coins were separated into two groups. One was officially minted, and another was privately minted. The privately minted coins have poor quality and are considered to have less value than the officially minted ones. The historical documents of Japan recorded the coins called Bita-sen (銚錢) or Bita-zeni (銚錢), which means bad coin or privately minted coin.
It is said that privately minted coins of Chinese Tang, Northern Song, Southern Song and early Ming era were massively minted in Japan. And also privately minted coin of the Yongle Tongbao were minted in Japan. However, it is difficult to perfectly distinguish every coin between officially minted coin and privately minted coin. In Japan, two opinions are in conflict. One opinion states the Yongle Tongbao excavated in Japan would include various privately minted coin, particularly coins, minted in eastern region of Japan\(^8\). Another opinion indicates that the Yongle Tongbao excavated in Japan would be almost the officially minted coin\(^9\). These two opinions have each ground, and the conflict of the opinion is not settled.

Nakamura tried to classify the coins using a technique of chemical analysis. Fig. 2 shows the analytical results of Cu, Pb, Sn in the coins. As shown in the figure, we were not successful in classifying two groups of coins merely by the composition of these three elements. We could hardly classify the Yongle Tongbao of Wakimoto and Kabari hoards into officially minted and privately minted coins. The authors, Kobayashi and Nakamura, tried to use new method to sort coins by the ratio of copper and tin\(^{10}\). The result will be presented in section 4.

3. Excavation of Krasnokurovka burial ground

Krasnokurovka burial ground was first discovered by Vasil’ev Yu. M., in 1972, with announcement of Silin A. T., who was a resident of the village of Kukan\(^{11}\).

The graves are situated about 5-7km south-southeast of the village of Pobeda in the Khabarovsky municipal district, 3km from the Krasnokurovka hill, on a high (3-4m) left bank of the river Kur. The village of Novokurovka (that was the center of Kur-Urmiya district of the Khabarovsky Territory until 1963) is situated 15km the southwardly (Fig.3).

The graves itself are located 50-70m to the south-southwest from the old apiary. The length of the graves from the east to the west is 150m, from the north to the south it is 115-120m, and the area is about 1.8 hectares. The graves include 82 embankments of various forms (rectangular, rounded, and square), that are arranged in rows. Chains of mounds are not arranged in regular order: the rows are formed either of some closely adjacent embankments or of the embankments that set separately from each other. If required, at least 9 rows of mounds can be counted, stretching in the direction from the southwest to the northeast and the southeast to the northwest (Fig.4).

The necropolis consists of two groups, the first (and possibly the oldest) includes the mounds Nos. 37-82. It is very compact, the embankments are closely adjacent to each other and a half or more are round barrows. The second group (Nos. 1-36) mainly consists of square and rectangular barrows that are more scattered.
The diameter of the rounded burial mounds of the graves is from 3m to 7.5m. The square barrows have the side length that varies from 3.5m to 4m. The dimensions of the rectangular barrows are from 2.0×2.5m to 7.0×5.0m or even larger. The largest of them (No.18) is 10.5×7.0m. Many mounds have been strongly slid, so in some cases the mounds determined during the survey as rounded, may well turn out to be square in the excavations. They are surrounded by the trenches that are often adjacent. Some round and rectangular barrows have up to 4 barriers in their trenches. All round barrows are characterized by the presence of 1 to 6 pits of ancient origin with a diameter of 0.7m to 2.5m on their tops.

The stones of separated mounds, protrude to the surface. The nearest outcrops of such breeds were found not closer than 2.5km away on the eastern shore of Novokurovsky bay.

Fifteen graves (Nos. 2, 7, 9, 10, 18, 19, 22, 23, 29, 30, 31, 32, 54, 55, 56) of the burial ground and 2 pits located southwardly of the grave No. 64 were researched stationary in 1984, 1986 and 1987 of the 20th century. The materials are dated from the 12th to the 13th centuries.

4. The Yongle Tongbao discovered in the Krasnokurovka burial ground and its chemical analysis

The material number of the Yongle Tongbao discovered in the Krasnokurovka burial ground is ‘KP9333-3’. This coin was discovered in the mound No. 30 named by Vasil'ev Yu. M.. The Photograph of the coin is shown in Fig.7. The weight is 3.4g, diameter is 24.6mm, size of square center hole is 5.4mm and thickness is 0.9mm. The measured values are similar to these of the coins discovered in Japan. It is said that the diameter of privately minted coin became small, for example under 24.0mm. Thus,
‘KP9333-3’ is considered as an officially minted coin. However, the Chinese characters on the front face look slightly thick and crushed. So that the possibility that ‘KP9333-3’ belongs to the privately minted coin is not strictly excluded.

One of the authors, Murakushi, measured Cu, Pb, Sn composition by a handheld X-ray fluorescence analyzer, Niton XL3t-900S. The measurements were done for two points in front face and back face by the standard alloys mode in 1 minute each.

The value of tin of ‘KP 9333-3’ is higher than that of lead. This is a rare phenomenon in the excavated Yongle Tongbao in Japan especially in Hokkaido Island (Fig.2). It should be mentioned that this is a result of the chemical analysis of surface of the patina on the coins, not internal bulk alloy of coins. Kobayashi, one of the authors, studied the relationship between the internal composition and the surface composition of the coins. The new method of Kobayashi is as follows.

50 pieces of the Kan’ei Tūhō were measured by SEM-EDS. The section of all pieces keeps metallic luster. The internal and surface composition is well correlated with the correction coefficient of 0.88. Thus, it was possible to estimate the internal Sn/Cu ratio from the surface Sn/Cu ratio of the coin.

10 pieces of the Yongle Tongbao have then been examined. And the values of Yongle Tongbao got on the regression line of the Kan’ei Tūhō. So he concluded that this regression line could apply to every old coins. Furthermore, 205 pieces of the Yongle Tongbao of Wakimoto hoard were tested, and the internal and surface compositions are plotted in Fig. 8.

Lead is alloyed with tin, however not copper which is the main component. Because the composition of lead in coins which we analyzed, is higher than that of tin relatively, the lead segregates in the coin. Therefore, the composition of lead varies in the different analyzed point in the coin. In general, component metals are eluted from coins which are aged and corroded. Because the variation of the lead composition, the surface and the internal Sn/Pb ratios are not correlated. However, copper and tin in the

<table>
<thead>
<tr>
<th>The upper part of front face</th>
<th>The lower part of front face</th>
<th>The upper part of back face</th>
<th>The lower part of back face</th>
<th>Average of four points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu 74.7</td>
<td>Cu 75.8</td>
<td>Cu 77.3</td>
<td>Cu 77.4</td>
<td>Cu 76.3</td>
</tr>
<tr>
<td>Pb 12.3</td>
<td>Pb 11.6</td>
<td>Pb 10.4</td>
<td>Pb 9.5</td>
<td>Pb 11.0</td>
</tr>
<tr>
<td>Sn 13.0</td>
<td>Sn 12.6</td>
<td>Sn 12.3</td>
<td>Sn 13.1</td>
<td>Sn 12.7</td>
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Fig. 8 Internal compositions of Sn/Cu ratio of Yongle Tongbao in Khabarovsk Museum (4 blue plots) estimated on the basis of a regression line obtained from the Yongle Tongbao of Wakimoto hoard
surface of the coin are eluted uniformly when the coin is corroded. So, it is thought that the surface and the internal Sn/Cu ratios are well correlated.

Most of the data are in the internal composition range of 0.05-0.08. This result suggests that these coins were proceeded under a strongly controlled process. So there is a high possibility that the coins in the range of 0.05-0.08 are officially minted coins. The points deviating from the range of 0.05-0.08 are considered as the privately minted coins. As Fig.8 shows, the internal composition of ‘KP 9333-3’ estimated as the value within the range of 0.05-0.08. So ‘KP 9333-3’ cannot be regarded as privately minted coin.

5. Another relics excavated in the mound No.30

Eleven kinds of relics were excavated in the mound No.30 (See legends in Fig. 5). The English translation of the legends of Fig. 5 is as follows.

1- coin; 2- nail; 3- bracket; 4- buckle; 5- chalcedony; 6- human tooth; 7- iron; 8- birch bark; 9- pottery; 10- burnt bone; 11- glass bead

Three kind of relics, 1-coin, 4-buckle and 7-iron remained. Fig. 9 and 10 show more two Chinese coins. Fig. 9 shows the Zhenglong Yuanbao (正隆元寶) of Jin (金) Dynasty. This coin was first minted in 1158 and the material number of this coin is ‘KP 9333-2’. Fig. 10 shows the Kaiyuan Tongbao of the Tang dynasty. Its material number is ‘KP 9333-4’. Fig.11 shows iron buckle from a belt. Fig.12 shows a piece of the iron pot. The remaining items were removed by Vasil’ev, Yu. M. in the 1990s and these are still missing.
6. Conclusion

This article reports the chemical analysis of the Yongle Tongbao in Northeast Asia at the first time. Looking at the result of the chemical analysis, we conclude that the possibility is low for ‘KP 9333-3’ to be a privately minted coin.

Vasil’ev, Yu. M. indicated that the mound No.30 dated from the 12th to the 13th centuries. However, the Yongle Tongbao which was first minted in 1408 discovered in the mound No.30. So, it is necessary to reconsider the end period of the Pokrovka culture.

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